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IN THE UNITED STATES PATENT & TRADEMARK OFFICE

IN RE APPLICATION OF	:
MASAMOTO UENISHI, ET AL.	: EXAMINER: VICTOR CHANG
SERIAL NO: 09/623,474	:
FILED: SEPTEMBER 13, 2000	: GROUP ART UNIT: 1771
FOR: COMPOSITE HOLLOW FIBER MEMBRANE AND METHOD OF PRODUCING THE SAME	:

REPLY BRIEF

COMMISSIONER FOR PATENTS
ALEXANDRIA, VIRGINIA 22313

SIR:

This Reply Brief is responsive to the Examiner's Answer mailed December 31, 2003.

The Examiner notes on page 2 of the Examiner's Answer that the Appeal Brief does not contain a statement identifying the related appeals and interferences. However, the Examiner and the Board are directed to II. Related Appeals and Interferences at page 1 of the Appeal Brief, in which it was stated "To the best of Appellants' undersigned representative's knowledge, there are no related appeals or interferences."

The Examiner's notation of the minor errors in the claims on appeal on page 3 of the Examiner's Answer is acknowledged. Enclosed is a correct copy of the claims on Appeal.

It should be further noted that all references to mm in the Examiner's Answer should be μm, since all thicknesses recited in the various claims are in microns (μm), not millimeters (mm).

The Examiner alleges on page 7 of the Examiner's Answer that EP 074952A1 teaches that, because the prior art teaches that for a membrane with uniform micropores there is an inverse relation between water permeability and separation capability, the invention of EP 074952A1 is directed to a multilayered membrane to meet both requirements of high water permeability and high separation capability (EP 074952A1, pages 2-3, bridging paragraph). However, a reading of the description of the prior art on page 2 of EP 0740952A1 finds no such statement of an inverse relation between water permeability and separation capability, but only a statement that for membranes with uniform micropores, large water permeability and sufficient separation characteristics are not assured by the membranes of the prior art.

The Examiner states on page 8 of the Examiner's Answer that,

> "Although the only example for a three-layered membrane (Ex. 3) shows a low porosity of only 64%, one of ordinary skill in the art would find that the calculated b-layer thickness (assuming a symmetrical structure) of Ex. 3 is only 28 mm, which is clearly much less than the typical b-layer thickness, as shown in the two-layered membrane, and when considering the teachings of EP 074952A1 as a whole, the particularly thin b-layer of Ex 3, which renders the membrane having a lower porosity, does not appear to be a representative thickness".

However, when one looks at the total thickness of the microporous membrane, which is in a range of 5 to 500 μm (EP 0740952A1, page 3, line 37) and the thickness range of the a-layer, which is within the range of 0.5 and 20 μm, it can clearly be seen that Example 3 is a representative example of the microporous membrane of the reference. Further, EP 0740952A1 does not show a particularly thin b-layer, as asserted by the Examiner, and, therefore, the b-layer of Ex. 3 would have no effect on the overall porosity of the membrane of the example.

At the bottom of page 8 and the top of page 9 of the Examiner's Answer the Examiner alleges that the reference does not teach Ex. 3 as a limiting example, that the teaching of the reference clearly encompasses the high porosity element of the three-layered structure of the

claimed invention and is an obvious optimization to one of ordinary skill in the art. However, EP 0740952A1 does not set forth any overall porosity range for the hollow fiber membrane of the reference anywhere in the specification and only shows porosity %s in Table 1. Further EP 0740952A1 does not set forth the advantages of having the overall porosity of a composite hollow fiber membrane of the present invention of not less than 75% by volume, as discussed on page 20, lines 4-8 of the specification, which describes that filtration life of the membrane is extended by making the porosity 75% by volume or higher.

The Examiner argues on pages 9 and 10 of the Examiner's Answer that the limitation on the isothermal crystallization time τ s of the resin used for the outermost layer and the innermost layer and the isothermal crystallization time τ p of the resin used for the dense layer satisfying the relationship: $1 < \tau p / \tau s < 100$ is an inherent physical property of the polyolefins required by the membrane manufacturing process or an obvious optimization to one of ordinary skill in the art. The Examiner further argues that this limitation is a product-by-process limitation and Applicants must show that the resultant article is patentably distinct from those taught by the reference.

However, it is clear that the ratio of the isothermal crystallization times between the membrane layers is not a product-by-process limitation, but a physical limitation on the membrane of the present claims. Since the discussion of the isothermal crystallization time τ on pages 25 and 26 of the specification clearly indicates that the selection of the type of polymer for each layer is critical in order to satisfy the relationship of: $1 < \tau p / \tau s < 100$ and is not dependent on process of making the membrane and there is no teaching or suggestion in the reference for any isothermal crystallization time for any of the resins used to produce the hollow fiber membrane of the reference, there can be no motivation in the reference to the worker of ordinary skill in the art to arrive at composite hollow fiber membranes having the ratio of present claim 1. Finally, the specification on page 26 clearly indicates, if the ratio

exceeds 100, orientation of the resins in the direction of the thickness of the membrane is disturbed, resulting in a non-uniform distribution of micropore sizes after stretching and unsatisfactory performance of the composite hollow fiber membrane. Therefore, Appellants have provided evidentiary support that the composite hollow fiber membrane of the present claims is structurally affected by the ratio of the isothermal crystallization times of the resins used in the formation of the membrane.

With regard to the comparative data presented in the specification the Examiner contends that the comparison is not objective and fair, since the porosities of the comparative examples are lower than the porosities of up to 76% in the examples on Table 1 of the reference.

Table 1 of EP 0740952A1

	Mean Distance Between Microfibril Bundles (μm)		Db/Da	Mean Distance Between Knotted Portions (μm)		Internal Diameter (μm)	Membrane Thickness of A-Layer (μm)	Total Membrane Thickness (μm)	Membrane Thickness of A-Layer/Total Membrane Thickness	EVOH Adhesion (WT%)	Mean Particle Diameter at which not less than 90% is cut	Maximum Pore Diameter by B.P. Method (μm)	Porosity (%)	Permeability ($1/m^2$/r. mmHg)
	Da	Db		La	Lb									
Ex. 1	0.17	0.33	1.94	0.32	0.54	278	10	62	0.161	8.7	0.055	0.09	64	1.30
Ex. 2	0.35	0.54	1.54	0.77	1.00	458	8	84	0.095	10.5	0.170	0.30	76	8.70
Ex. 3	0.19	0.33	1.74	0.33	0.55	280	4	60	0.067	7.8	0.065	0.10	64	1.60
Ex. 4	0.21	0.39	1.86	0.38	0.76	281	12	62	0.192	8.5	0.088	0.14	70	2.90
Ex. 5	0.20	0.40	2.00	0.38	0.75	276	10	61	0.164	8.7	0.088	0.17	60	2.60
Ex. 6	0.27	0.47	1.74	0.46	0.94	456	11	83	0.133	10.2	0.115	0.24	75	5.30
Ex. 7	0.10	0.21	2.10	0.20	0.40	278	4	61	0.065	11.0	0.038	0.04	68	0.16
Ex. 8	0.23	0.54	2.35	0.40	1.01	456	10	85	0.118	10.4	0.102	0.19	76	4.30
Ex. 9	0.17	0.53	3.12	0.33	1.00	458	8	83	0.096	10.5	0.065	0.10	76	2.30
Ex. 10	0.35	0.56	1.60	0.75	1.03	280	8	61	0.132	8.5	0.170	0.30	76	5.70
Con. 1	0.17			0.31		281		63		9.0	0.055	0.09	58	0.24
Con. 2	0.20			0.38		279		60		8.5	0.088	0.15	62	0.65
Con. 3	0.34			0.75		278		61		8.8	0.170	0.30	69	3.30
Con. 4	0.11			0.21		275		62		11.0	0.038	0.04	45	0.04

However, it can be seen that the differences between the examples in the specification, 73% and 73.5%, are only slightly lower than the top porosity of 76% of some of the two-layer membranes of Table 1 and better than or comparable to many other of the examples in Table 1. It is submitted that the comparisons in the specification are apposite to a showing of superior results with the present invention, as compared to what is shown in the reference. The Examiner's characterization of the results for the claimed invention as not appearing to be superior is contested, since the water permeation percentage differences range from 6% to 20% better for examples of the present invention, as compared to the comparative examples. Further, there are large differences between the examples of the present invention and the comparative examples in the tests "Accumulated amount of water permeated through continuous water permeation test." Finally, the Examiner notes that there is no three-layer comparative example presented in Table 2 of the present application.

Table 2 of the present specification

	Composite hollow fiber membrane after being subjected to hydrophilization treatment								
	Porosity	Inner diameter	Outer diameter	Thickness of inner support layer	Thickness of dense layer	Thickness of outer support layer	Air flux	Water permeation amount	Accumulated amount of water permeated through continuous water permeation test
	Vol%	μm	μm	μm	μm	μm	$\times 10^3$L/ (m^2 hr KPa)	L/(m^2 hr KPa)	L/(m^2 KPa)
Example 1	77.8	229	382	32.7	11.7	32.7	15.2	36.1	65.0
Example 2	77.6	284	469	40.0	12.6	40.0	13.7	35.5	66.8
Example 3	78.0	239	360	45.0	6.8	8.6	12.2	36.7	80.5
Example 4	77.2	256	390	30.9	5.0	30.9	15.2	38.6	90.2
Example 5	78.2	252	388	31.5	5.0	31.5	15.1	35.5	90.6
Comp. Example 1	73.0	250	384	-	7.7	59.3	14.9	33.4	60.2
Comp. Example 2	73.5	293	437	60.0	12.2	-	9.5	32.1	22.5
Comp. Example 3	72.0	270	380	Single-layer membrane having a film thickness of 55 μm			7.6	18.9	28.0
Comp. Example 4	72.0	270	380	Single-layer membrane having a film thickness of 55 μm			8.8	21.7	32.0

However, it can be seen that Examples 4 and 5 of Table 2 of the present application have layers which are very close to the thickness of the layers of Example 3 of Table 1 of the reference. Examples 4 and 5 of Table 2 of the present application have porosity of 77.2% and 78.2%, respectively, while the porosity of Example 3 is 64%, significantly lower. This lends further credence to Appellants' argument that the limitation on the ratio of isothermal crystallization times for the resins used in the membrane of the present claims is a significant factor in producing the high porosity levels of the membranes of the present claims.

The Examiner argues on pages 11 and 12 that the "specific initial water permeation" of Claim 8 is either inherently disclosed in the reference, as evidenced by the permanent hydrophilic property in the membrane, or an obvious optimization to one of ordinary skill in the art. However, since the reference does not teach or suggest any "specific initial water permeation" amount for the membrane of the reference, there is nothing in the reference to indicate that such property would be inherent in the membrane of the reference and the worker of ordinary skill in the art would not be led to optimize a property which is undisclosed in the reference.

In view of the preceding arguments, Appellants respectfully request that the Examiner's rejection of Claims 1, 3-8 and 11-17 be REVERSED.

Respectfully submitted,

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APPENDIX

Pending claims on appeal in U.S. Application 09/623,474

1. A composite hollow fiber membrane comprising three or more layers of membrane comprising a three-dimensional net structure comprising a plurality of micropores comprising stacked lamella and micro fibrils connected with the stacked lamella, wherein

one or more dense layer(s), said dense layer(s) being thinner than an outermost layer and an innermost layer and said dense layer(s) comprising micropores of a mean pore diameter smaller than that of the micropores of the outermost layer and the innermost layer, is disposed as intermediate layer(s), between the outermost layer and the innermost layer, wherein the composite hollow fiber membrane has overall porosity of not less than 75% by volume, and wherein

the isothermal crystallization time τs of the resin used for the outermost layer and the innermost layer and the isothermal crystallization time τp of the resin used for the dense layer satisfy the following relationship:

$1 < \tau p/\tau s < 100$.

3. The membrane according to Claim 1, wherein the outermost layer and the innermost layer have a mean microfibril length in a range from 0.5 to 10 μm and mean distance between microfibrils in a range from 0.1 to 0.6 μm.

4. The membrane according to Claim 1, wherein the dense layer has a mean microfibril length in a range from 0.2 to 5 μm and a mean distance between microfibrils in a range from 0.02 to 0.3 μm.

5. The membrane according to Claim 1, wherein each of the outermost layer and the innermost layer has a thickness in a range from 5 to 50 μm.

6. The membrane according to Claim 1, wherein the dense layer has a thickness in a range from 3 to 15 μm.

7. The membrane according to Claim 1, further comprising a cover layer of a hydrophilic polymer.

8. The membrane according to Claim 1, wherein the initial water permeation amount is 25.0 L/(m2 × hr × kPa) or higher.

11. The membrane according to Claim 7, wherein the microfibrils are divided into groups of a plurality of pieces that are bundled together and said plurality of micropores are elliptic.

12. The membrane according to Claim 1, comprising a cover layer of a hydrophilic polymer and wherein the microfibrils comprise bundled groups of microfibrils.

13. The membrane of Claim 1, wherein said layers comprise thermoplastic resin(s).

14. The membrane of Claim 11, wherein said resin(s) are polyamide(s) or polyolefin(s).

15. The membrane of Claim 12, wherein said polyolefin(s) are isotactic polypropylene, poly-4-methyl-1-pentene, poly-e-methylbutene-1 and polyvinylidene fluoride and mixtures thereof.

16. The membrane of Claim 1, wherein the inner diameter is in a range from 50 to 5000 μm.

17. The membrane of Claim 1, wherein the total thickness is in a range of from 30 to 200 μm.